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Letter to the Editor

SINGULARITIES IN WEDGE-SHAPED, ANTISYMMETRIC, COMPOSITE LAMINATES

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The partial differential equations which govern the behavior of unsymmetric laminates are coupled, in the sense that bending and in-plane deformations are not independent. This coupling, which is absent in the symmetric case, considerably complicates the analysis of singularities. eneral discussions of stress singularities in anisotropic media, a related field, can be found in Refs. [1], [2], [3].

The present investigation is concerned with singular fields in wedge-shaped, antisymmetric, composite laminates on whose edges are imposed typical boundary conditions. Expressions of the form

$$\begin{aligned} u_o &= Ar^{\lambda} e^{s\theta} \\ v_o &= Br^{\lambda} e^{s\theta} \\ w_o &= Cr^{\lambda+1} e^{s\theta} \end{aligned} \qquad (1)$$

are assumed for the dependent variables u_o, v_o and w_o, which are the displacements of the midplane in the radial, tangential and transverse directions, respectively. In eqs. (1), A, B, C are constants, r and θ are polar coordinates and λ and s have to be determined. Satisfaction of the differential equations of equilibrium leads to a full 8th order polynomial in s, the coefficients of which are functions of the unknown λ. Application of the boundary conditions leads to an eigenvalue problem involving an 8 x 8 matrix for the determination of λ. Since the roots of the polynomial in s cannot be written down explicitly, the eigenvalue problem is, in fact, nonlinear.

A graphite/epoxy laminate (T-300/5208) with 8 layers, each of thickness 1/4 mm, is currently being investigated. Numerical results are being sought through an iterative procedure for various ply angles and boundary conditions. An initial guess is made for λ(the corresponding value for the symmetric cases will be used). Then the eigenvalue problem will be solved (using NAAS:EISPACK) to obtain a new value of λ and iteration will be performed until satisfactory accuracy is obtained.

REFERENCES

1. S.E. Mikhailov, Izv. AN SSSR. Mech. Tverd. Tela, 14, 33 (1979).
2. T.C.T. Ting and S.C. Chou, Int. J. Solids Structures, 17, 1057 (1981).
3. T.C.T. Ting, Int. J. Solids Structures, 18, 139 (1982).